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Meeting Record

IMS: 00-RU-0057

MEETING PURPOSE: RU/BNFL Topical Meeting to discuss Cesium (Cs) Storage Vessel Cooling and the Seismic Dose Consequence Evaluation for the BNFL Facility

MEETING DATE/TIME: October 26, 1999/1:00 – 5:00 PM

MEETING PLACE: Skamania Room, BNFL Facility
3000 George Washington Way
Richland, WA 99352

AGENDA:

1. Regulatory Unit (RU) Opening Remarks

2. BNFL discussion of Cs Storage Vessel Cooling and the Seismic Dose Consequence Evaluation for the BNFL Facility

ATTENDEES: See Attachment 1

PREPARED BY: Ko Chen

CONCURRENCE: George Kalman

KEY DISCUSSION ITEMS:

The meeting began with a welcome from the RU, the introduction of attendees (Attachment 1) and a review of the meeting agenda. The RU then briefly went over the transition issues since the September topical meeting (Attachment 2). The transition issues included the following:

- A preliminary topical report on Cs storage vessel cooling was received by the RU on September 29, 1999.

- A level 1 meeting on Cs storage vessel cooling was held between the RU and BNFL on October 5, 1999.

- A level 1 meeting on seismic PRA and dose consequence evaluation was held between the RU and BNFL on October 7, 1999.

- The topical report of Cs storage vessel cooling was received by the RU on October 12, 1999. The report was updated by BNFL on October 22, 1999.

- The September topical meeting minutes were issued by the RU on October 14, 1999.

Status of ISA Open Issues and Questions

There has been no change on the statues of ISA open issues and questions since the September topical meeting.

The Current Status of ISA Open Issues and Questions

116 items are closed and 17 remain open.

Status of Topical Meeting Action Items

There has been no change on the status since the September topical meeting.

BNFL Review Comments on the September Topical Meeting Minutes

BNFL had not completed its review due to late release of the September topical meeting minutes by the RU.

BNFL Presentation

After this brief overview by the RU, the BNFL portion of the program began. The two primary subjects for the topical meeting were the BNFL control strategy for Cs storage vessel cooling (Attachment 3) and the dose consequence evaluation for beyond the design basis seismic events (Attachments 4 and 5).

Introduction of BNFL Control Strategy of Cs Storage Vessel Cooling (Attachment 3)

The topical meeting included a discussion of the BNFL control strategy for the loss of cooling to the Cs (and technetium) storage vessel. The discussion focused on the control of hazards associated with boiling of the Cs storage vessel contents due to the decay heat generated by the concentrated radionuclides following the loss of cooling to the vessel.

In its Design Safety Features (DSF) submittal (February 1999), BNFL stated that its primary control strategy of the Cs storage vessel boiling was to rely on passive cooling. Since the submittal, the BNFL control strategy has changed from strictly passive cooling to consideration of active cooling, passive cooling, and the cooling contribution of the Process Vessel Ventilation System (PVVS). BNFL stated that the change was based on the following considerations:

- The size of the Cs storage vessel and the location have been changed. The size of the vessel has been reduced from 45 cubic meters to 28 cubic meters. The location of the vessel is now located approximately at the center of the Pretreatment Building.

- BNFL has concluded that strictly passive cooling may not be achievable for this configuration.

- The BNFL control strategy on hydrogen explosion has been switched from passive to active ventilation. The Process Vessel Ventilation System (PVVS) is now deployed to the Cs storage vessel.

In addition, BNFL stated its analytical assumptions of the consequence calculation for the Cs Storage vessel boiling were changed based on an evaluation performed just prior to the topical meeting. Following are the highlights of the change:

- A new value of airborne release fraction (ARF), 1.7E-5, is used instead of the value (2.0E-3) from the Department of Energy (DOE) handbook, DOE-HDBK-3010. BNFL stated that the new ARF is based on its Sellafield Release Fraction database. BNFL emphasized that the new ARF value was derived from the measurements based on test conditions similar to those of Tank Waste Remediation System-Privatization (TWRS-P) facility. Therefore, BNFL concluded that the use of Sellafield Release Fraction database is appropriate for its facility.

- A decontamination factor (DF) of 10 is used for a pressurized, seismically qualified cell (applied only to facility worker dose calculation). A DF of 1 is used for co-located workers and the public. In its DSF submittal, BNFL used a DF of 100 for facility workers and a DF of 10 for co-located workers and the public.

- The mean best basis Cs 137 content, 13M Ci, is used for dose calculations. This inventory leads to 61 Kilowatts of decay heat, responding to RU questions, BNFL stated the decay heat has been increased from 42 Kilowatts to 61 Kilowatts due to the increased inventory of Cs in the vessel.

- The vessel heat-up calculation following loss of cooling will include heat release to the environment.

- The vessel size has been changed from 45 cubic meters to 28 cubic meters.

Based on the new assumptions and for an unmitigated radiological release as a result of the Cs storage vessel boiling, BNFL calculated the dose consequences to be 0.33 rem, 1E-03 rem and 30 rem respectively for co-located workers, the public and facility workers. The unmitigated dose consequence for facility workers (30 rem) places the unmitigated event in the severity level 1 (SL 1) category.

The RU will review the above information as a part of its evaluation of the BNFL dose agreement methodology, which was submitted to the RU on October 27, 1999.

<u>Work and Hazard Identification of Cs Storage Vessel Cooling</u>

At the meeting, BNFL provided the following information of its Cs storage vessel: the process flow diagram, the basis for Cs 137 inventory, the vessel storage conditions and detailed vessel descriptions. These details are included in the BNFL handout (Attachment 3).

<u>Cs Storage Vessel Passive Cooling Heat Transfer Analysis</u>

BNFL performed a heat transfer analysis to predict the temperature of the Cs storage vessel following a postulated loss of cooling event. The analysis modeled the heat transfer from the Cs storage vessel to the vessel wall by natural convection, then to the cell wall by both natural convection and radiation. Finally, the heat is transferred from the outer cell wall to the environment. The heat transfer analysis was performed on four cases: a small vessel (28 cubic meters, the current BNFL design basis Cs storage vessel) with and without adiabatic vessel wall, and a large vessel (160 cubic meters) with and without adiabatic vessel wall. The BNFL calculation showed that it will take 1.25 days for the vessel to reach the boiling temperature (230 F) assuming a small vessel with adiabatic wall, and 61 Kw heat input.

Responding to a RU question, BNFL indicated that in addition to addressing the passive cooling issue another objective of the heat transfer analysis was to estimate the available time for workers to evacuate following a loss of cooling event to the Cs storage vessel.

The RU questioned the value of the heat transfer coefficient from the Cs solution in the storage vessel to the vessel wall. The RU will review the heat transfer calculation once the transfer coefficient is ascertained.

Cs Storage Vessel Dose Consequence Calculation

BNFL provided the rationale for its use of the revised ARF and DF (Attachment 3).

In response to a pre-meeting, RU question concerning technetium (Tc) volatility, BNFL responded that based on Savannah River Company experiments, very little Tc is expected to volatilize in conditions similar to what would be expected in the Cs storage tank. An ARF below 2E-03 would be expected.

The RU raised numerous questions about the Sellafield database.

The following are some of the exchanges:

- What is the reason for the change from a DF of 10 to a DF of 1 for both co-located workers and the public? BNFL responded that the change was made, partially due to the RU comments that any system, structure and component (SSC), operated actively, should not be credited for an unmitigated dose calculation. The change was also based on BNFL's re-assessment of its Sellfafiled database. In the Sellafield database, the use of DF of 10 was based on the assumption that a filter was in place. BNFL concluded that this was not appropriate for its dose calculation of unmitigated consequences.

- What is the basis for a DF of 100 used by BNFL for workers in BNFL DSF submittal? The use of DF of 100 is based on BNFL interpretation of its Sellafield database for an intact cell, under the condition of no pressurization.

- How does BNFL reconcile the difference between its Sellafield database and DOE handbook? BNFL has made a comparison study on the difference and provided technical justifications for the difference. The comparison study was included in the BNFL document of dose methodology, submitted on October 27, 1999. The RU will review the submittal and evaluate whether the proposed ARF and DF are appropriate.

- What is the duration of BNFL boil-off tests to derive the ARF values? All tests were performed under steady state conditions, i.e. boil-off was considered.

- What is the accuracy and precision of the Sellafield database? BNFL has not performed this type assessment on its database.

- The RU noted that the ARF based on Sellafield database is about two orders of magnitudes less than the DOE Handbook value (1.7E-5 vs. 2.0E-3).

BNFL responded that the ARF value from its database was derived under the test conditions very similar to that of TWRS-P. Therefore, in BNFL's view it is appropriate to use that value.

Control Strategy Development for Cs Storage Vessel Heating

BNFL described its development of a control strategy to deal with the Cs storage vessel heating. The objective is to provide a safe and reliable means of cooling the Cs storage vessel. Strategies under consideration include passive cooling, active cooling, and cooling via the PVVS. The objective of passive cooling is to demonstrate its viability for an extended time interval. The evaluation is still in progress.

BNFL is considering the following three options for its active control strategy:

- Separate emergency and normal cooling loops
- Redundant cooling loops with air-blast coolers
- Redundant cooling loops with water chillers.

BNFL has performed a reliability assessment of these options. The BNFL assessment concluded that the target reliability (<10E-4 per year) for all three options can be achieved. However, a third train would be required to reach target reliability associated with SL-1 unmitigated events (<10E-6 per year).

BNFL concluded that:

- Based on its heat transfer analysis, passive cooling will provide enough time (1.25 day) for facility workers to evacuate in the event of an accident.

- Active cooling strategy can meet SL-1 related target reliability.

- An agreement on dose assessment methodology between the RU and BNFL is desired by BNFL before BNFL proceeds with further design of this system.

Based on its schedule, BNFL's final decision on its control strategy is expected to be made by March 2000.

Once the control strategy is finalized by BNFL, the RU will evaluate the chosen option and its associated reliability assessment.

Seismic Probabilistic Risk Analysis (PRA) for the RPP-WTP (Attachment 4)

BNFL first provided a brief history of the evolution of its strategy to comply with TWRS-P radiation exposure limits for seismic events beyond the design basis earthquake (DBE). BNFL initially proposed to use a seismic PRA to achieve that goal. BNFL then proposed a seismic margin study as a less costly alternative. Prior to the topical meeting, the RU clarified what methods may be acceptable for meeting the dose standards. After consideration of the options, BNFL decided to use a seismic PRA to demonstrate that the design of BNFL facility will comply with the TWRS-P radiation exposure limits.

BNFL stated that its seismic PRA will use the following guiding principles:

- To demonstrate compliance with radiation exposure limit, the seismic PRA will use an iterative, bounding analysis.

- The seismic PRA will use, as appropriate, best (non-biased) estimates of radioactive source terms and radiation exposure parameters.

In order to carry out the seismic PRA, BNFL will extrapolate the mean seismic hazard curve for the Hanford site to an appropriate ground motion level required to estimate events with frequencies less than 10E-6 per year.

BNFL stated a complete seismic PRA consists of the following steps:

1. Estimate the fragility parameters for SSCs and establish fragility curves for those SSCs. Based on fragility curves, the seismic capacity of SSCs can be determined. The fragility curve for each SSC is defined for a specific damage state, i.e., from a state of minor damage and low leak rate (incipient failure) to a state of high leak rate and significant structure failure.
   The initial PRA will be based on an incipient damage level of each SSC.

2. Establish a screening level based on a target facility performance level. The purpose of the screening criterion is to identify the SSCs that have sufficiently high seismic capacity and therefore can be screened out from further evaluation.

3. Develop an inventory of the TWRS-P facility SSCs, whose failure could lead, to radiological releases.

4. Develop a TWRS-P facility seismic event tree model that identifies the accident sequences, which can lead to radiological release.

5. Perform a radiological release and exposure analysis for each accident sequence (or group of sequences that have similar radiological consequences). Evaluate the magnitude of radiological releases to workers, co-located workers and the public.

6. Review the initial risk analysis results to determine if the frequency and magnitude of radiological exposures satisfy the TWRS-P radiation exposure limits. If the limits are satisfied, compliance is demonstrated and the seismic PRA is completed.

7. If the compliance is not demonstrated, a systematic review of the results is conducted to identify the accident sequences and SSCs, whose failures are the primary contributors to the TWRS-P facility risk. Once these critical SSCs are identified, more realistic fragility parameters (higher damage state) will be developed and further strengthening of seismic design for these SSCs may be required.

8. Re-evaluate the TWRS-P facility seismic risk (step 5) with the alternative strategies from step 7.

9. Iterate the process (from step 6) until compliance with TWRS-P radiation exposure limit is demonstrated.

The RU raised questions on the seismic PRA approach. Following are the more significant issues:

- Has BNFL considered other options for extending the seismic hazards curve? BNFL will use the linear extrapolation as a first approximation. If a more sophisticated method is required to extend the curve to ensure excessive conservatism is not introduced, BNFL will consider asking Geomatrix to do the work.

- How does BNFL perform the seismic PRA without all the design information of the facility? BNFL will use whatever design information is available at that time when the PRA is performed. BNFL will re-evaluate the PRA work when all design for the facility is finalized.

- Will BNFL provide more detail to describe the PRA? BNFL will provide the RU with a detailed description of its PRA approach in writing.

- If the initial PRA is based on SSCs with minor damage state, i.e., small crack and low leak rate, would the facility risk based on SSCs with more serious damage state (serious structure failure and high leak rate) ever be evaluated?

If compliance is demonstrated based on SSCs with minor damage level, there is no need to go any further. It is because SSCs with higher damage level will occur less frequently.

If compliance is not demonstrated, PRA will be iterated with higher damage levels for SSCs. The process will continue until compliance is demonstrated.

- Has BNFL developed a schedule for the PRA? BNFL has not developed one, but will develop a schedule in the near future.

During the discussion, it was noted that BNFL refers to the project as the RPP-WTP. The RU was directed by DOE Headquarters to revert to the former nomenclature, TWRS-P. The Regulatory Official (RO) clarified that BNFL is free to choose the name it uses for its project. RPP-WTP is an acceptable choice.

Dose Assessment Methodology for Seismic Events (Attachment 5)

BNFL stated that its dose assessment is based on the best estimates of radioactive source terms and radiation exposure parameters. These parameters are based on one of the following distribution functions: uniform distribution, triangle distribution, and normal and lognormal distribution.

Responding to a RU question, BNFL indicated that distributions based on actual data will be used if they are available.

Monte Carlo sampling technique is used for the following seismically independent parameters: tank inventory, activity concentration, airborne release fraction, respirable fraction, airborne release rate, exposure time, breathing rate, and atmospheric dispersion factor.

The results of dose assessment will be dose consequences vs. probability for each accident sequence. For each accident sequence, the probability of exceeding the dose limit, e.g., 25 rem, is multiplied by the frequency of occurrence. The result is called the frequency of exceeding dose limit for that particular accident sequence. The frequency of exceeding dose limit is then summed for all accident sequences considered. This resulting frequency after the summation represents the frequency for the whole facility with the dose consequence greater than the limit. If the resulting frequency for the whole facility is less than 1.0E-6 per year, compliance with the TWRS-P radiation exposure limit is demonstrated.

BNFL provided a sample calculation to illustrate the dose analysis methodology for seismic events. Failures of High Level Waste Receipt Tanks were used as examples. The detail is described in Attachment 5.

RU COMMENTS ON THE MEETING

The RU commented that the meeting has been useful for exchanging the information. However, the RU did not consider any of the discussed issues closed. Furthermore, the lack of timely delivery of topical meeting material did not give the RU enough time for a careful review of subjects in advance of the topical meeting. RU comments/questions would be included with the meeting minutes (Attachment 6).

ACTION ITEMS

1. BNFL will provide the response to the written review comments/questions associated with the Cs storage vessel cooling issues (Attachment 6).

2. BNFL will provide the RU with a document to describe its seismic PRA approach in detail in December 1999.

3. The RU will review the Cs storage vessel radiological release issues (ARF, DF, etc.) as a part of the evaluation of the BNFL dose methodology, submitted in the BNFL letter dated October 27, 1999.

4. The RU will review the BNFL heat transfer analysis of the Cs storage tank cooling.

INFORMATION EXCHANGED:

1. The RU meeting presentation material

2. BNFL handout on the Cs storage vessel cooling

3. BNFL handout on seismic PRA for the RPP-WTP

4. BNFL handout on Seismic Dose Assessment Methodology

ATTACHMENTS:

1. Attendance list
2. RU presentation material
3. BNFL handout on Cs storage vessel cooling
4. BNFL handout on seismic PRA for the RPP-WTP
5. BNFL handout on seismic dose assessment methodology
6. RU Review Questions and Comments